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## Contributions to the Mesozoic flora of the Atlantic coastal plain, X.—Maryland

EDWARD WILBER BERRY

One of the first attempts to correlate the strata of the Atlantic coastal plain with those of Europe, that by John Finch<sup>1</sup> in 1824, was based on the amber-bearing lignites of the Magothy formation found at Cape Sable in Anne Arundel County, Maryland, while only a few years later Richard Harlan<sup>2</sup> mentions "dicotyledonous lignite" from the deep cut of the Chesapeake & Delaware canal. These are among the earliest references to the remains of former vegetation preserved in the Upper Cretaceous deposits of Maryland. Two incidental references by Ward<sup>3</sup> show that the important plant-localities at Grove Point, Bodkin Point, Round Bay, and Brightseat were discovered between 1887 and 1893 and collections made from them. These, however, remained unstudied in the National Museum collections until the writer took up the study of these floras in 1904. Meanwhile but a single paper had appeared which was devoted to Maryland Upper Cretaceous paleobotany. This was a short paper by Knowlton<sup>4</sup> describing the structure of the amber bearing lignite at Cape Sable.

The writer has published several preliminary papers<sup>5</sup> containing descriptions of Upper Cretaceous plants from the Maryland area. The last of these, published in 1911, brought the known Magothy

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<sup>1</sup> Finch, J. Am. Jour. Sci. I. 7: 31-43. 1824.

<sup>2</sup> Harlan, R. Trans. Geol. Soc. Penna. 1: 46-112; 256-262. 1834, 1835.

<sup>3</sup> Ward, L. F. 8th Ann. Rep. U. S. Geol. Surv. 1886-87: 871. 1889; 15th Ann. Rep. U. S. Geol. Surv. 1893-94, pt. 2: 371-372. 1895.

<sup>4</sup> Knowlton, F. H. American amber-producing trees. Science II. 3: 582-584. f. 1-4. 1896.

<sup>5</sup> Berry, E. W. Fossil plants along the Chesapeake & Delaware Canal. Jour. N. Y. Bot. Gard. 7: 5-7. 1906. Contributions to the Mesozoic flora of the Atlantic coastal plain I. Bull. Torrey Club 33: 163-182. pl. 7-9. 1906. New species of plants from the Magothy formation. Johns Hopkins Univ. Circ. N. S. 1907 7: 82-89. f. 1-5. A new Cretaceous *Bauhinia*. Torreya 8: 218-219. 1908. Contributions to the Mesozoic flora of the Atlantic coastal plain, IV and VII. Bull. Torrey Club 37: 19-29. pl. 8. 1910; 38: 399-424. pl. 18, 19. 1911.

flora up to 88 species and recorded for the first time a species from the Matawan formation and fifteen species from the Raritan formation. During the last few years the manuscript for the Maryland Geological Survey monograph on the Upper Cretaceous has been completed so that it is now possible to present a brief summary of these floras, together with certain deductions regarding the age of the deposits.

#### THE RARITAN FLORA

The oldest of these Upper Cretaceous floras is that found in the Raritan formation, of the same age as the Amboy clays in New Jersey, whose flora occupied the late Professor Newberry for so many years. The Raritan formation in the vicinity of Raritan Bay in New Jersey carries several heavy beds of clay which have furnished a flora of 166 species.<sup>1</sup> In Maryland, however, the Raritan is not only thinner but it is predominantly sandy and has thus only yielded fragments of the varied flora found in its New Jersey extension. The Maryland Raritan flora is of especial interest nevertheless since it contains several characteristic forms of the Dakota sandstone of Kansas and Nebraska, such as *Aspidiophyllum*, *Protophyllum*, and *Araliopsis*, which have never before been found except in the type area of the West. There are nine localities in the Maryland Raritan where identifiable fossil plants have been found. These are, from northeast to southwest: Bull Mountain and Shannon Hill in Cecil County; Cedar Point in Baltimore County; Forked Creek and Drum Point RR. in Anne Arundel County; Brightseat and Glymont in Prince George's County; and East Washington Heights and Overlook Inn Road in the District of Columbia. Combining the identifications from these several localities gives the following list of species as comprising the known Raritan flora in Maryland:

<i>Cladophlebis socialis</i>	<i>Cinnamomum Newberryi</i>
<i>Asplenium Dicksonianum</i>	<i>Sassafras acutilobum</i>
<i>Podozamites lanceolatus</i>	<i>Aralia washingtoniana</i>
<i>Podozamites marginatus</i>	<i>Araliopsis breviloba</i>
<i>Czekanowskia capillaris</i>	<i>Araliopsis cretacea</i>
<i>Salix Lesquereuxii</i>	<i>Araliopsis cretacea dentata</i>

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<sup>1</sup> Berry, E. W. Bull. Geol. Surv. New Jersey 3. 1911.

<i>Ficus ovatifolia</i>	<i>Araliopsis cretacea salisburiaefolia</i>
<i>Platanus Heerii</i>	<i>Diospyros primaeva</i>
<i>Aspidiophyllum trilobatum</i>	<i>Diospyros vera</i>
<i>Protophyllum Sternbergii</i>	<i>Fontainea grandifolia</i>
<i>Protophyllum multinerve</i>	

The foregoing 21 forms include two ferns, two cycad-like species, one conifer, no monocotyledons and sixteen dicotyledons. The most abundant forms, due in a measure to their maceration-resisting character, are *Aspidiophyllum*, *Protophyllum*, *Platanus*, and *Araliopsis*.

#### THE MAGOTHY FLORA

The Magothy formation which overlies the Raritan formation unconformably is much richer in plant remains. In the Maryland region the following six localities have furnished identifiable fossil plants: Deep Cut of the Chesapeake & Delaware Canal, just east of the Maryland state line in Delaware; Grove Point in Cecil County; and Bodkin Point, Round Bay, Little Round Bay, and Cape Sable in Anne Arundel County. Combining the identifications from these six localities results in the following list:

<i>Sphaerites raritanensis</i>	<i>Carpites liriophylli</i>
<i>Algites americana</i>	<i>Nelumbites primaeva</i>
<i>Gleichenia Zippel</i>	<i>Cinnamomum Newberryi</i>
<i>Gleichenia delawarensis</i>	<i>Laurus proteaefolia</i>
<i>Gleichenia Saundersii</i>	<i>Laurus plutonia</i>
<i>Osmunda delawarensis</i>	<i>Laurus Hollickii</i>
<i>Onoclea inquirenda</i>	<i>Laurophyllum elegans</i>
<i>Asplenium cecilensis</i>	<i>Laurophyllum angustifolium</i>
<i>Williamsonia delawarensis</i>	<i>Sassafras acutilobum</i>
<i>Williamsonia marylandica</i>	<i>Leguminosites canavalioides</i>
<i>Podozamites Knowltoni</i>	<i>Leguminosites coronilloides</i>
<i>Araucaria bladenensis</i>	<i>Leguminosites omphalobioides</i>
<i>Araucaria marylandica</i>	<i>Liriodendropsis constricta</i>
<i>Brachyphyllum macrocarpum</i>	<i>Colutea obovata</i>
<i>Brachyphyllum macrocarpum for-</i>	<i>Colutea primordialis</i>
<i>mosum</i>	<i>Bauhinia marylandica</i>
<i>Protophyllocladus lobatus</i>	<i>Dalbergia severnensis</i>
<i>Protophyllocladus subintegrifolius</i>	<i>Crotonophyllum cretaceum</i>

<i>Sequoia heterophylla</i>	<i>Ilex severnensis</i>
<i>Sequoia ambigua</i>	<i>Elaeodendron marylandicum</i>
<i>Sequoia Reichenbachii</i>	<i>Celastrus arctica</i>
<i>Cupressinoxylon (?) Bibbinsi</i>	<i>Celastrorhynchium crenatum</i>
<i>Thuja cretacea</i>	<i>Celastrorhynchium undulatum</i>
<i>Juniperus hypnoides</i>	<i>Rhamnus apiculatus</i>
<i>Widdringtonites Reichii</i>	<i>Cissites Newberryi</i>
<i>Raritania gracilis</i>	<i>Cissites formosus magothiensis</i>
<i>Geinitzia formosa</i>	<i>Hedera cretacea</i>
<i>Moriconia americana</i>	<i>Hedera cecilensis</i>
<i>Carex Clarkii</i>	<i>Sterculia minima</i>
<i>Doryanthites cretacea</i>	<i>Sterculia cliffwoodensis</i>
<i>Pistia Nordenskiöldi</i>	<i>Eucalyptus attenuata</i> <sup>1</sup>
<i>Sabalites magothiensis</i>	<i>Eucalyptus latifolia</i>
<i>Myrica longa</i>	<i>Eucalyptus Geinitzi</i>
<i>Salix flexuosa</i>	<i>Eucalyptus Wardiana</i>
<i>Salix Lesquereuxii</i>	<i>Cornus cecilensis</i>
<i>Populus stygia</i>	<i>Cornus Forchhammeri</i>
<i>Quercus Morrisoniana</i>	<i>Aralia groenlandica</i>
<i>Quercus severnensis</i>	<i>Aralia Ravniana</i>
<i>Ficus daphnogenoides</i>	<i>Andromeda Cooki</i>
<i>Ficus Cecilensis</i>	<i>Andromeda Parlatorii</i>
<i>Ficus crassipes</i>	<i>Andromeda Novae-Caesareae</i>
<i>Ficus Krausiana</i>	<i>Andromeda grandifolia</i>
<i>Coccolobites cretaceus</i>	<i>Myrsine borealis</i>
<i>Magnolia Hollicki</i>	<i>Myrsine Gaudini</i>
<i>Magnolia Lacoana</i>	<i>Sapotacites Knowltoni</i>
<i>Magnolia longipes</i>	<i>Bumelia praenuntia</i>
<i>Magnolia obtusata</i>	<i>Diospyros primaeva</i>
<i>Magnolia Boulayana</i>	<i>Diospyros rotundifolia</i>
<i>Magnolia tenuifolia</i>	<i>Cordia apiculata</i>
<i>Magnolia Capellinii</i>	<i>Carpolithus septiloculus</i>
<i>Illicium deletoides</i>	

The foregoing list includes exactly one hundred species, of which six are ferns; 19 are gymnosperms; 4 are monocotyledons,

<sup>1</sup> Although no changes in nomenclature are made the writer does not regard these forms as true species of *Eucalyptus* but as representing the ancestral stock of the early Tertiary species of *Myrcia*.

including well marked leaves of a fan-palm; and 69 are dicotyledons, well distributed among the natural orders and in many cases foreshadowing the wonderful display in the rich subtropical floras of the Eocene of our southern states.

It is not worth while in the present brief abstract to present an analysis of the botanical character of this flora or the indicated ecological conditions, or to trace its members in detail beyond the confines of Maryland. A hint of the problems suggested by its study is given when it is stated that many of its elements are found northward as far as west Greenland in latitude 70°, reappearing on Marthas Vineyard and Block Island and extending from Staten Island to the valley of the Potomac, again reappearing in North and South Carolina, in western Alabama and again in northeastern Texas.

#### THE MATAWAN FLORA

The Matawan formation, a typically marine series of glauconitic sands with marine mollusca, is a unit which has been traced from Raritan Bay in New Jersey to the Potomac River. Its deposits often show evidence of shallow water origin in their lithologic character and in the contained lignite but they have yielded practically no fossil plants—a *Ficus* from New Jersey, fragments of undeterminable dicotyledons from Pennsylvania, and the following Araucarian cone-scale in Maryland, *i. e. Dammara cliffwoodensis*. This is a species described originally from the Magothy formation of New Jersey, one very close to the widespread *Dammara borealis* of Heer. It was found near Millersville in Anne Arundel County and is of importance since it would seem to indicate that the Magothy flora survived with but little change into at least the lower part of the Matawan formation. This fact, while of slight interest to the botanist, has this significance, that it helps to explain the association of a Magothy-like flora with a Matawan-like invertebrate fauna in the coastal plain of the South Atlantic states.

#### CONCLUSIONS

The present contribution is no place for a detailed discussion of correlation, nevertheless a statement of the general results of the writer's studies in terms of the standard European section can be given in a few words.

*Age of the Raritan.*—In a paper published in 1910 after a detailed study of the Raritan flora as typically developed in New Jersey the writer<sup>1</sup> showed that in terms of the European section it was unquestionably of Cenomanian age. The present study has only confirmed this conclusion, which is emphasized here since the late Professor Ward as well as some European paleobotanists have considered the Raritan as of Albian age while on the other hand certain American invertebrate paleontologists have held that it was even younger than Cenomanian.

*Age of the Magothy.*—The Magothy flora from its resemblance to that of the underlying Raritan has also been considered to be of Cenomanian age although the writer<sup>2</sup> has more than once suggested that it represented the Turonian stage. The paleobotanical studies carried on by the writer during the past eight years and covering the coastal plain from New York to Texas completely confirm this supposition. In preparation for the Maryland report the Upper Cretaceous floras of Europe were all restudied in the light of the most recent stratigraphic and paleontologic work in France, Germany, Bohemia, etc. Detailed comparisons have shown that no less than six of the Magothy species are known from the European Turonian, while several additional are represented in the two areas by closely related forms, so that the Turonian age of the Magothy may be regarded as established. With regard to the overlying Matawan formation, since it has an abundant fauna any statements regarding its age may be postponed for the present, although it is interesting to know that several invertebrate paleontologists have correlated it also with the Turonian, a correlation that receives some measure of support from a study of the floras.

All of the forms mentioned on the preceding pages will be fully described and figured in the forthcoming volume of the Maryland Geological Survey, in which will also be found the results of detailed studies by various authors of the genesis of the sediments, the faunas, ecology, correlation and local geology.

JOHNS HOPKINS UNIVERSITY  
BALTIMORE, MARYLAND

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<sup>1</sup> Berry, E. W. Journ. Geol. 18: 252-258. 1910.

<sup>2</sup> E.g. in 1912 in The Coastal Plain of North Carolina, pp. 309-312.